Status of the measurement of the main K_L branching ratios

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Introduction

Improvements w.r.t. February presentation:

- New vertex from K_L tracks
- Neutral vertex added
- New generator for ke3γ (only ...)
- New MC (better agreement for resolutions and much more statistic)
- Ready for the measurements !?!
- All results are based on 2**** 2001 runs and $\phi\rightarrow$all 2001 MC

Tag bias: reminder

$K_S \to \pi^+\pi^-$ selection:

ε

- 63% — Rt < 10 cm; |z| < 20 cm; $|m-m_K|$ < 5 MeV; $|p^*-p^*_K|$ < 10 MeV

Main bias is expected from trigger

→ require trigger from K_S pions:

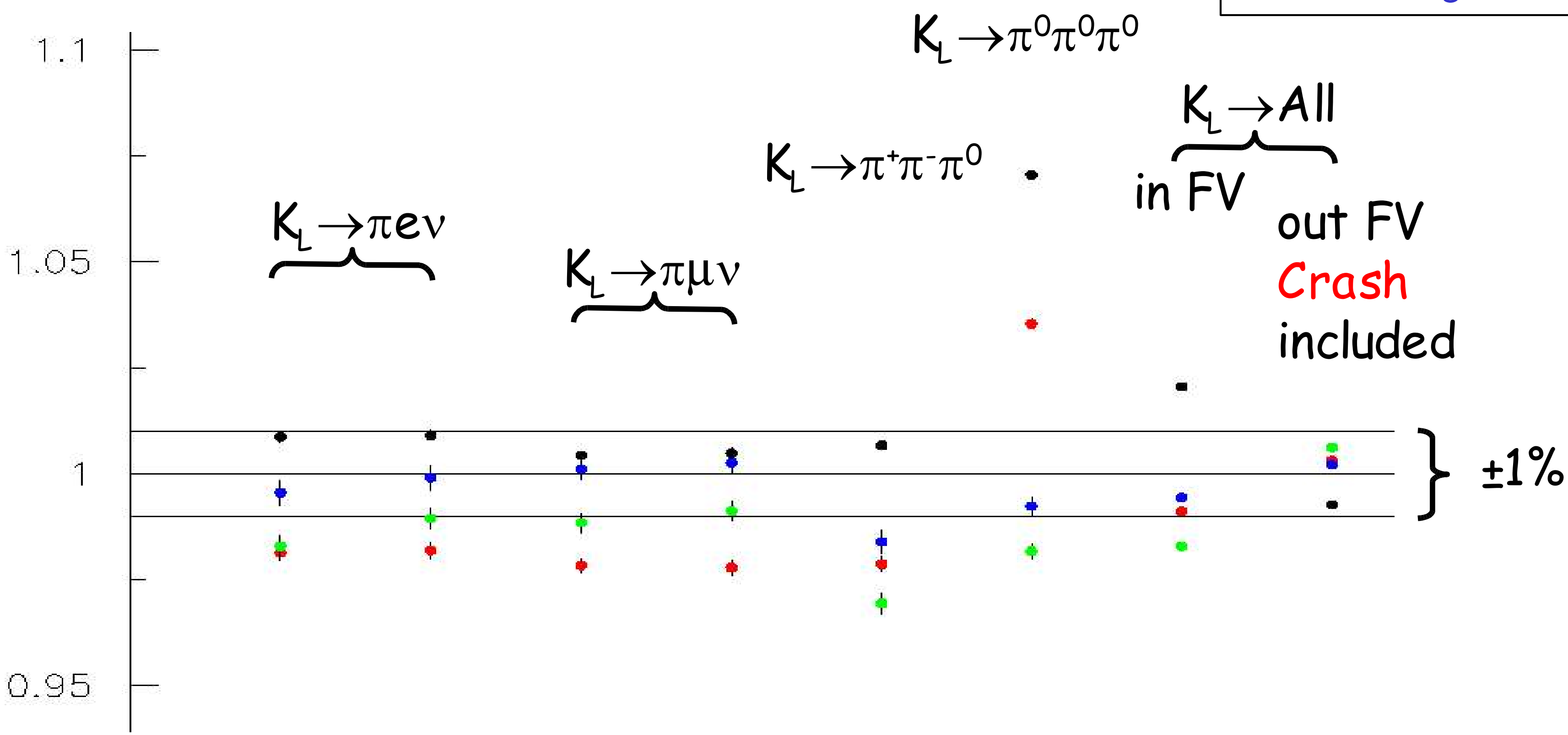
- 39% — clusters connected to fired trigger sector
- 25% — no other cluster in "K_S sectors" (avoid overlaps)
- 20% — no splitted pion tracks (T2CL asso. quality) + K_S direction far from beam line ($\cos(\theta)$>0.9)

Tag bias: NEWMC results

ε	K_L tag
63%	standard
39%	K_S trigger
25%	+ ~~overlaps~~
20%	+ tracks q. K_S dir.

Relative $K_S \to \pi^+\pi^-$ efficiency for various K_L process

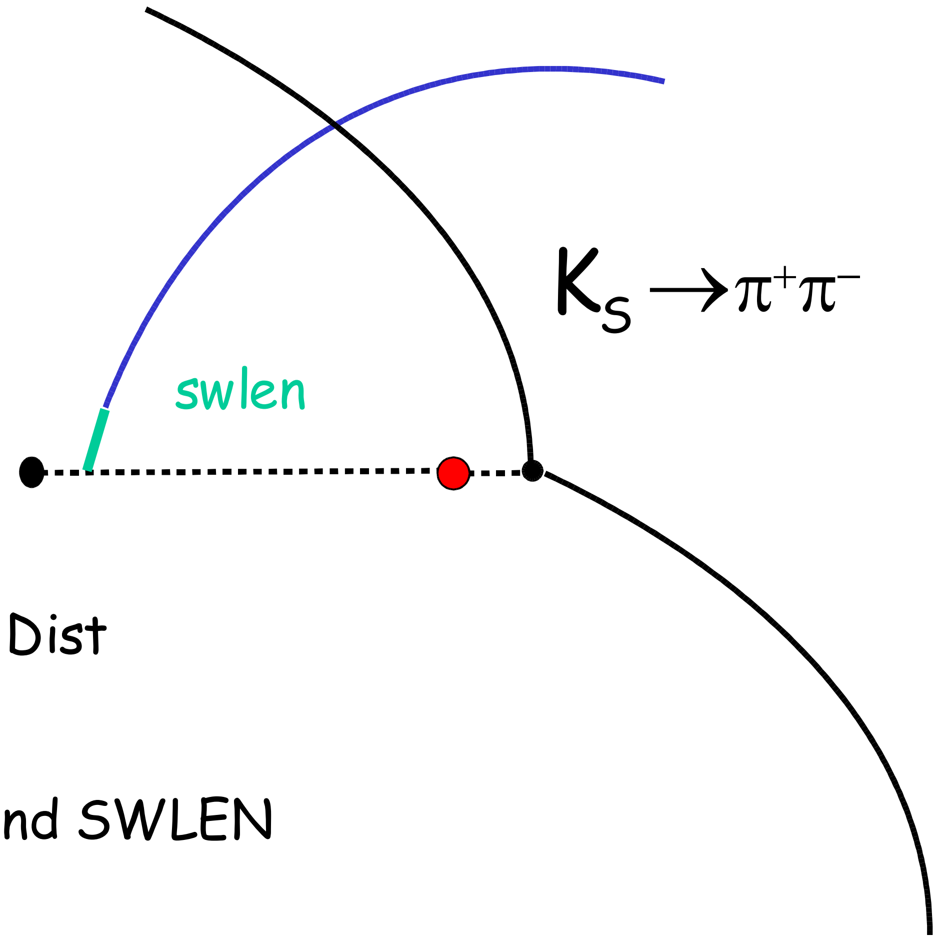
35 < Rt < 150 cm, |z| < 120 cm



Tracking + Vertex efficiency

Double tag method (from $K_L \to \pi^+\pi^-$ analysis)

Conditional efficiency
N_2/N_1 from data



Tag definition:
sliding cuts on DIST and SWLEN

Tracking + Vertex efficiency

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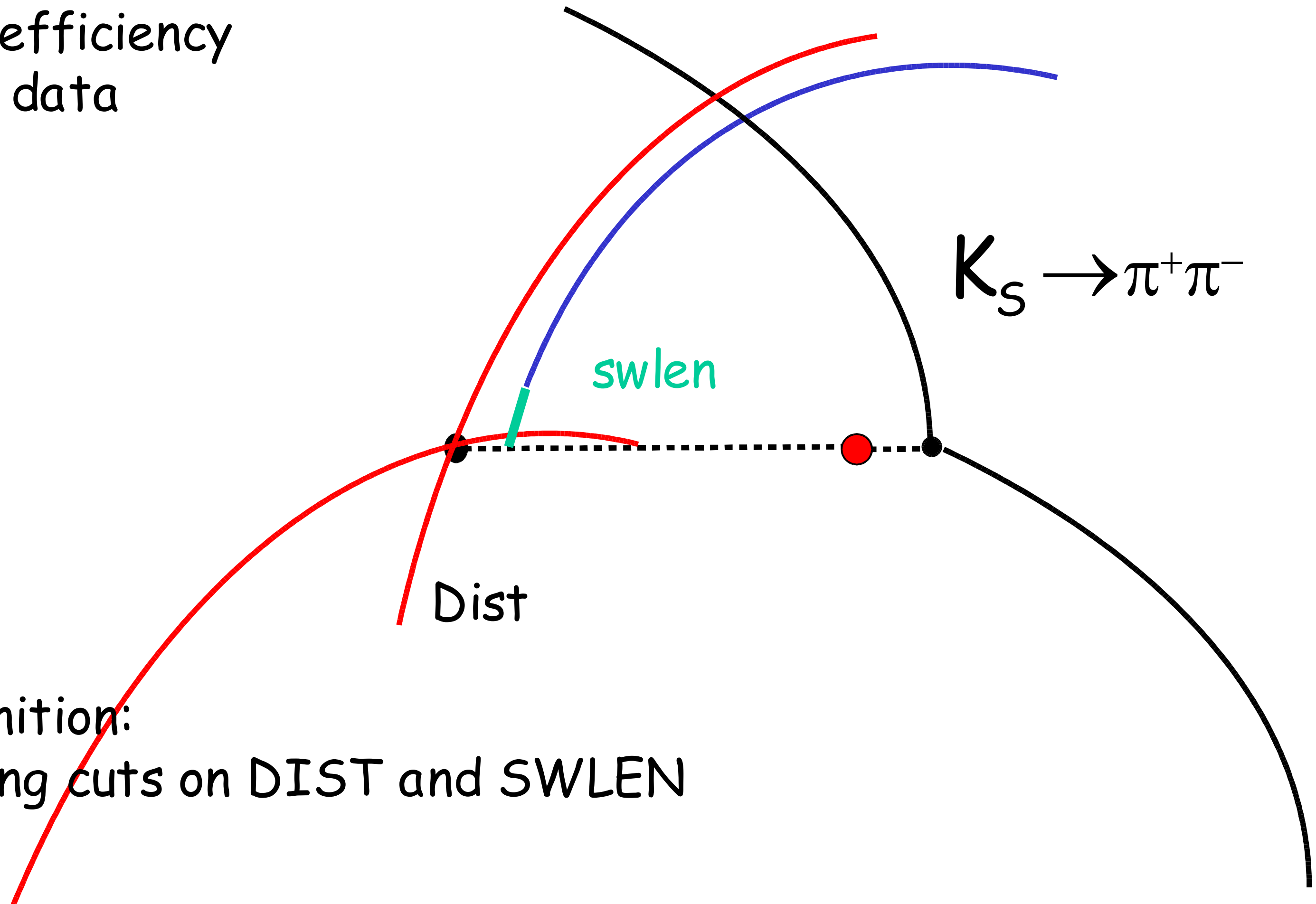
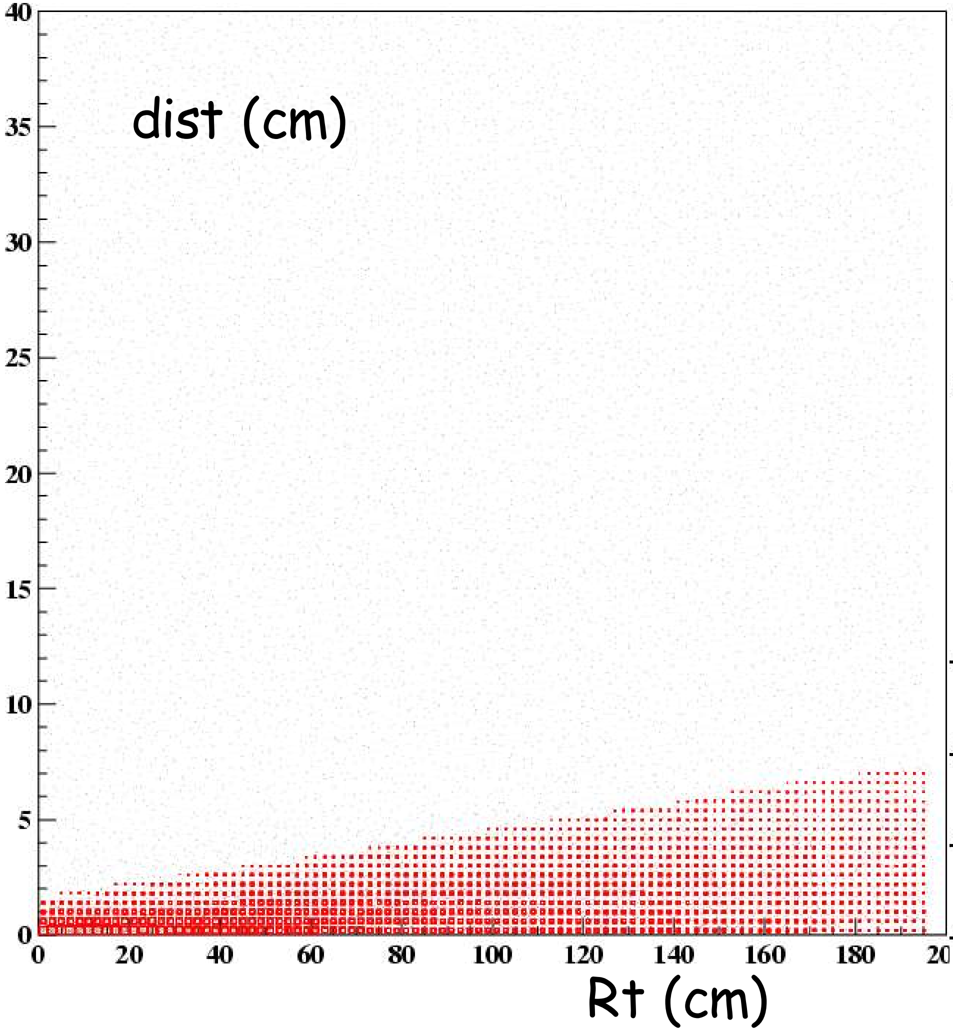
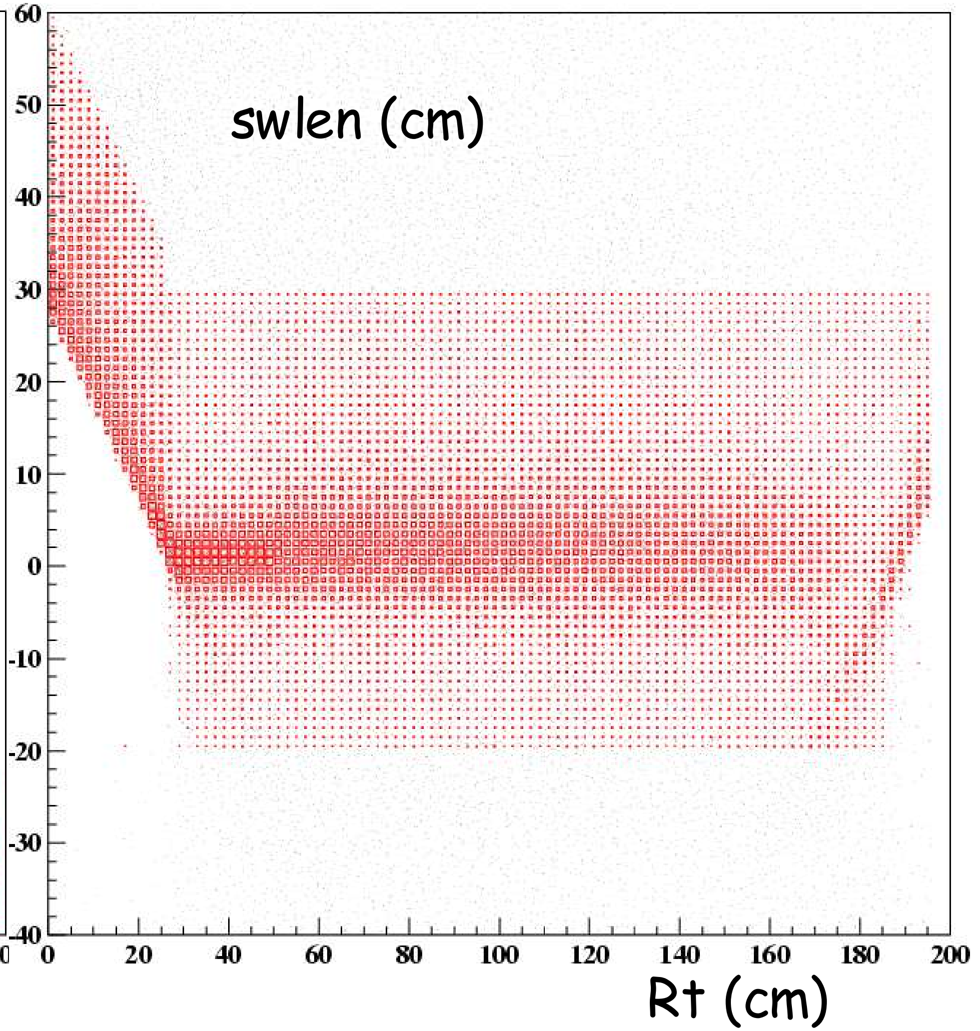


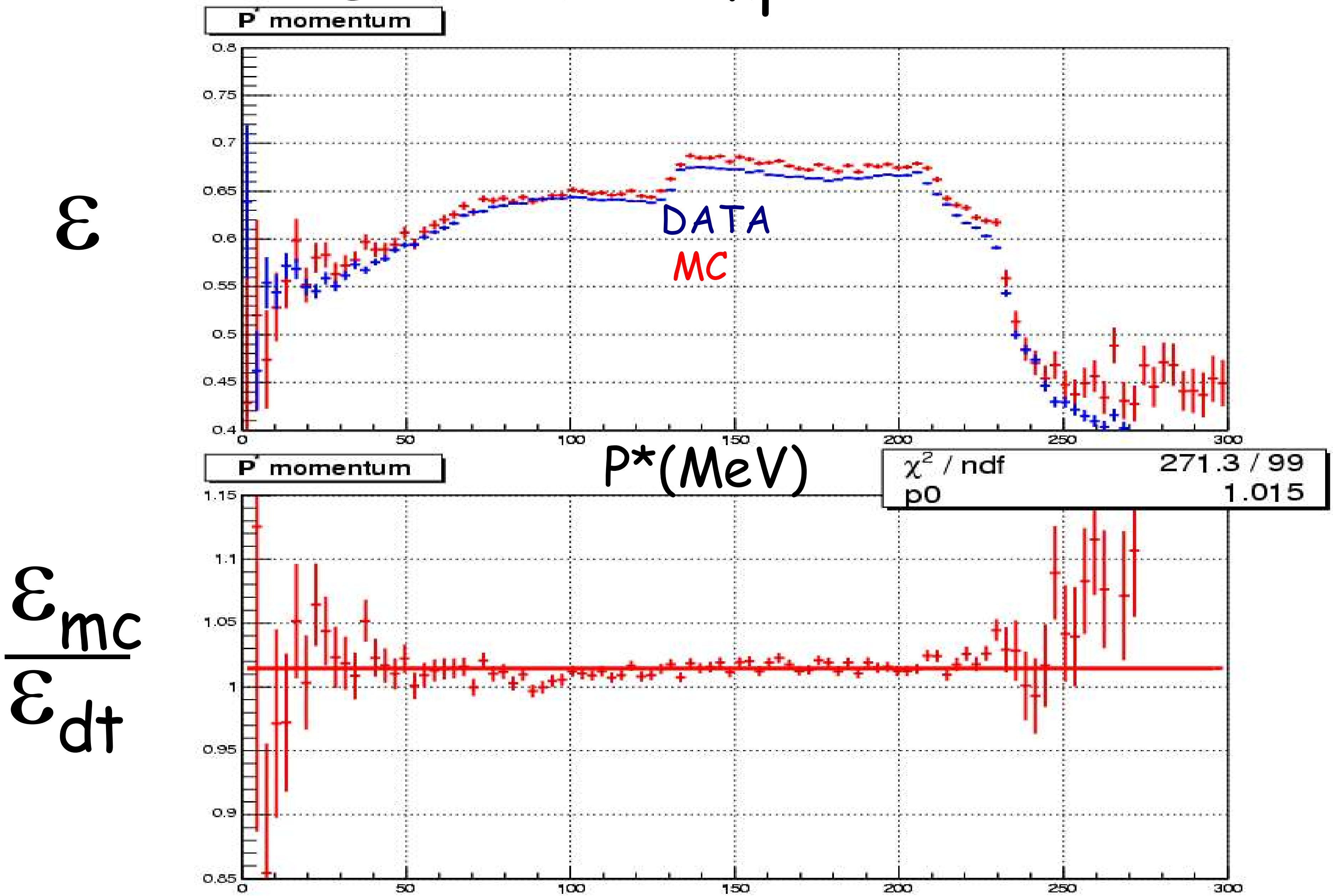
Tag definition:
sliding cuts on DIST and SWLEN

Track selection





Data-MC comparison



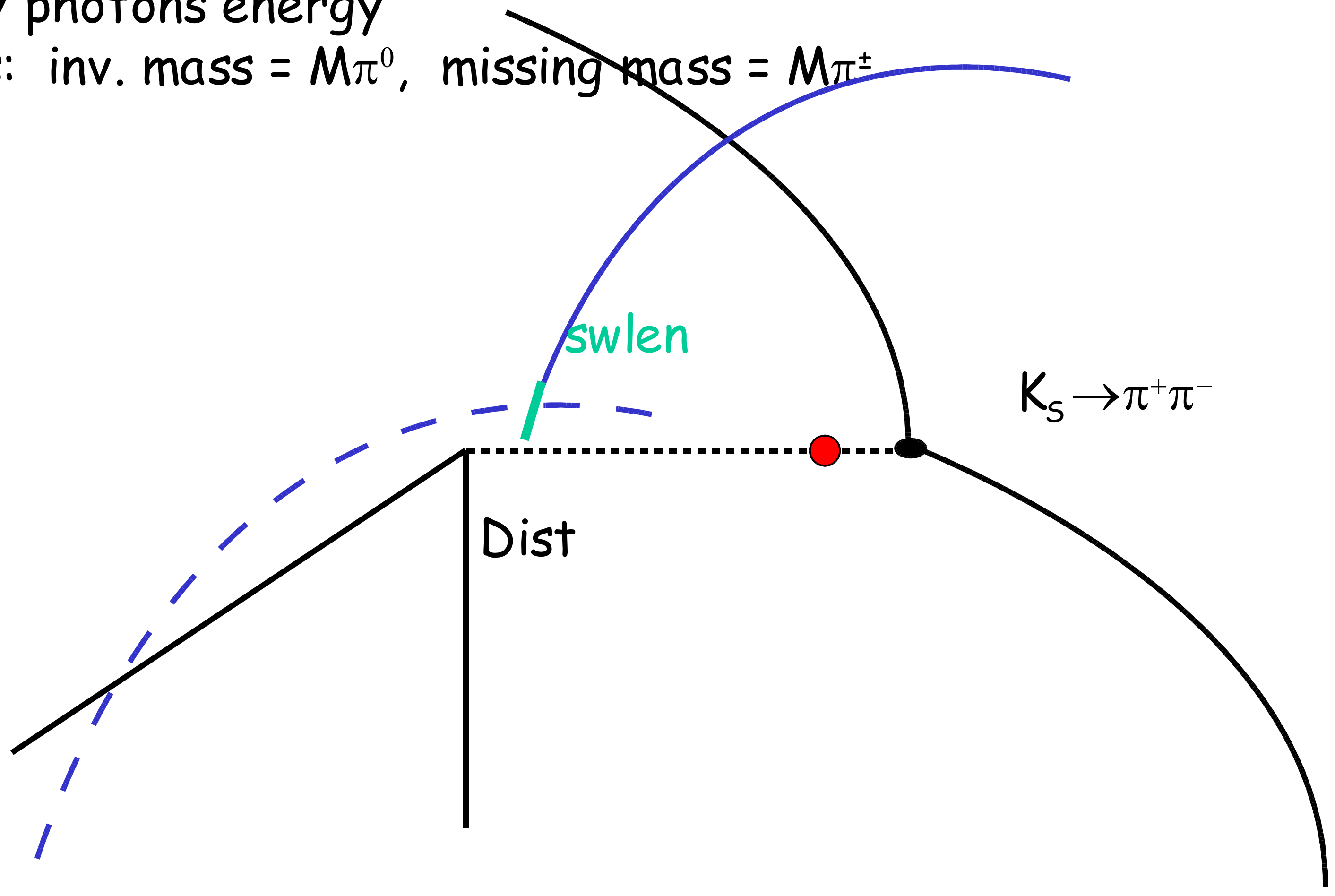
Tracking efficiency-method 2

Standard double tag method does not allow the a priori evaluation of the momentum of the 2nd K_L track, and could have some bkg at 1 K_L track level (K_L interactions with walls, calo. ..)

Use $K_L \to \pi^+\pi^-\pi^0$ with a kinematic fit:

Change only photons energy

Constraints: inv. mass = $M\pi^0$, missing mass = $M\pi^\pm$



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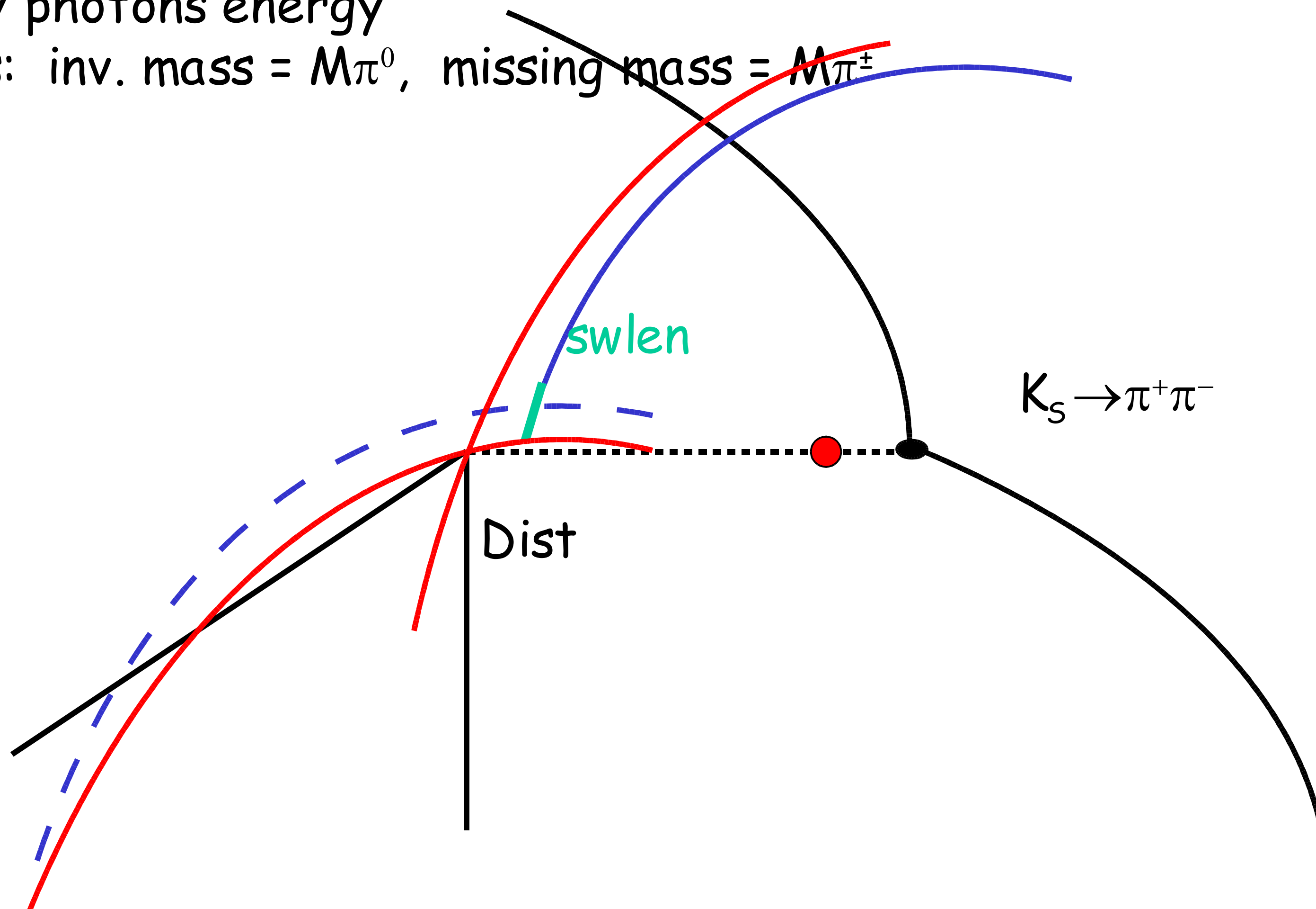

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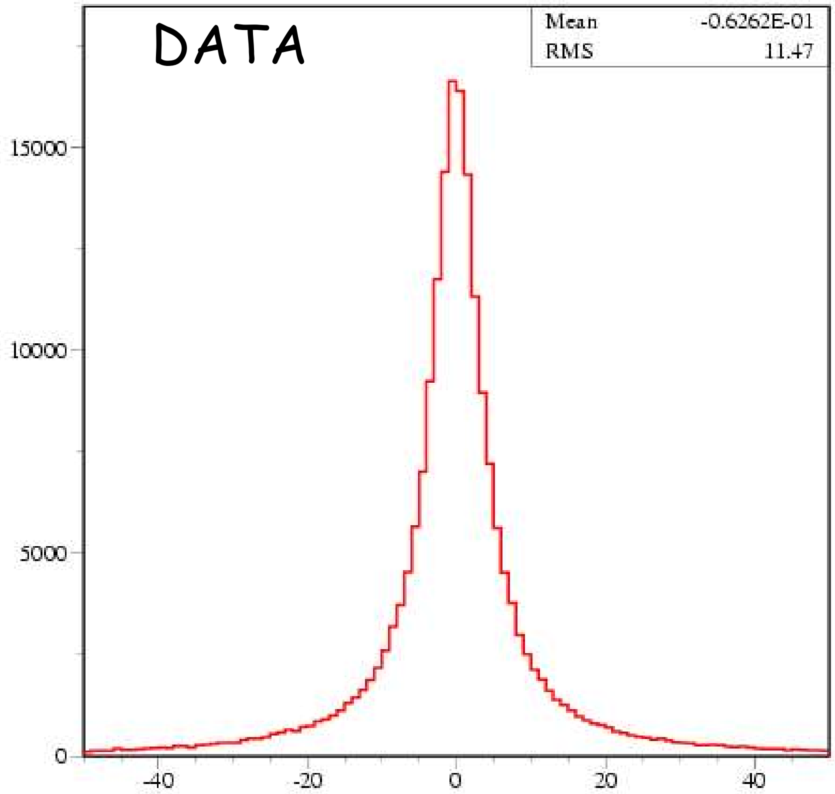
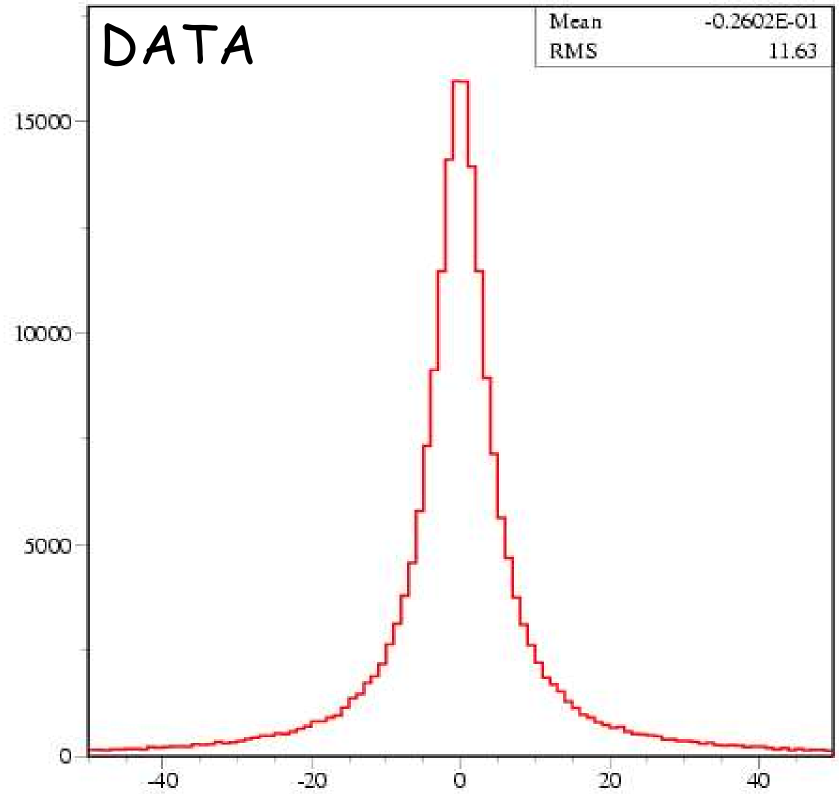
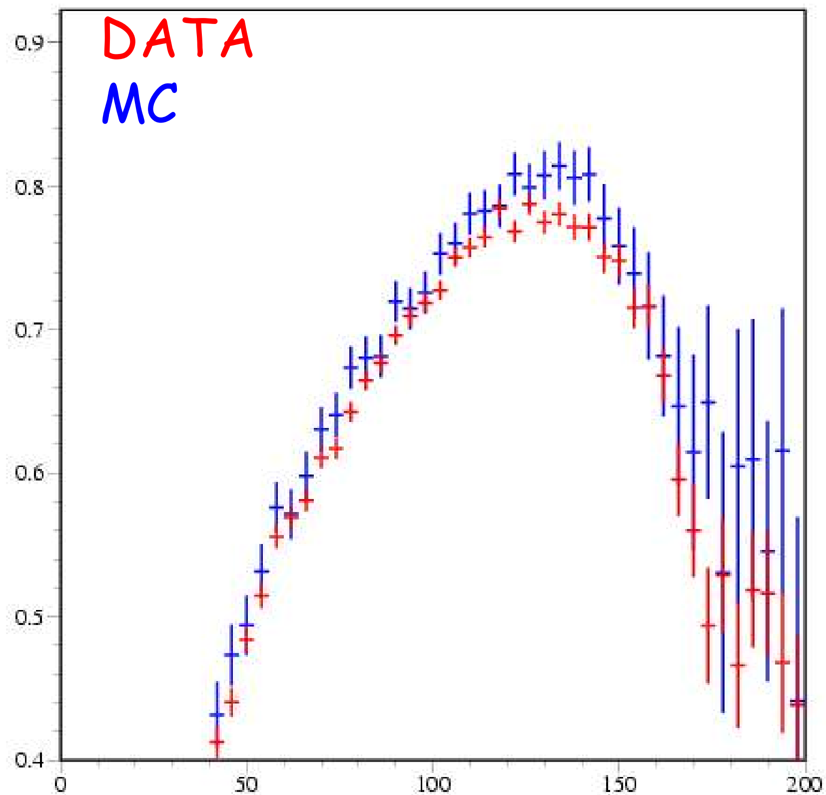


$P_x - P_x$(expected)

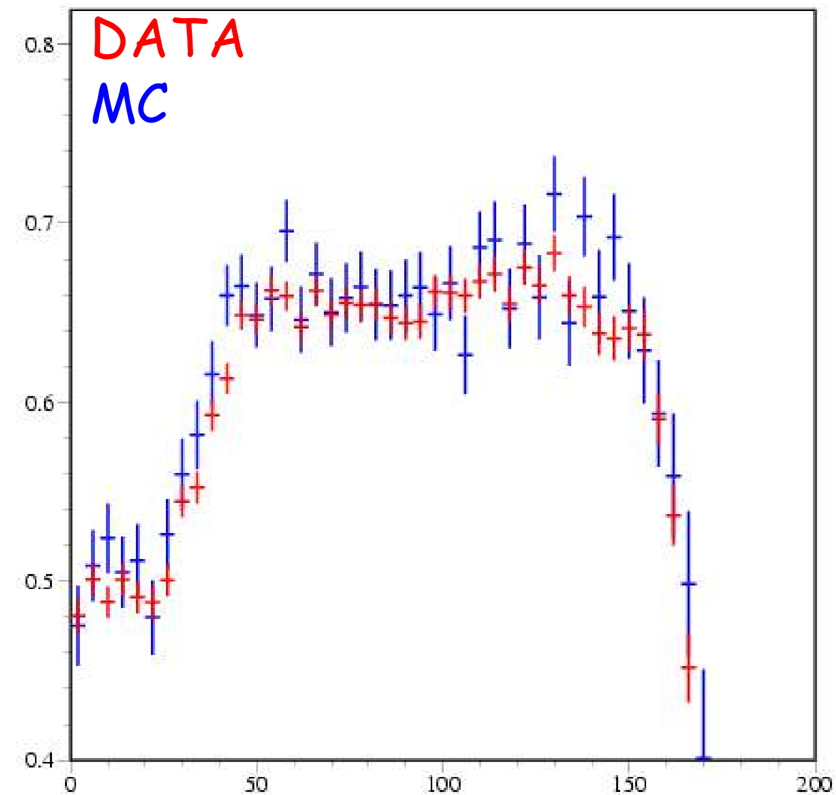


$P_y - P_y$(expected)

Tracking efficiency method 2



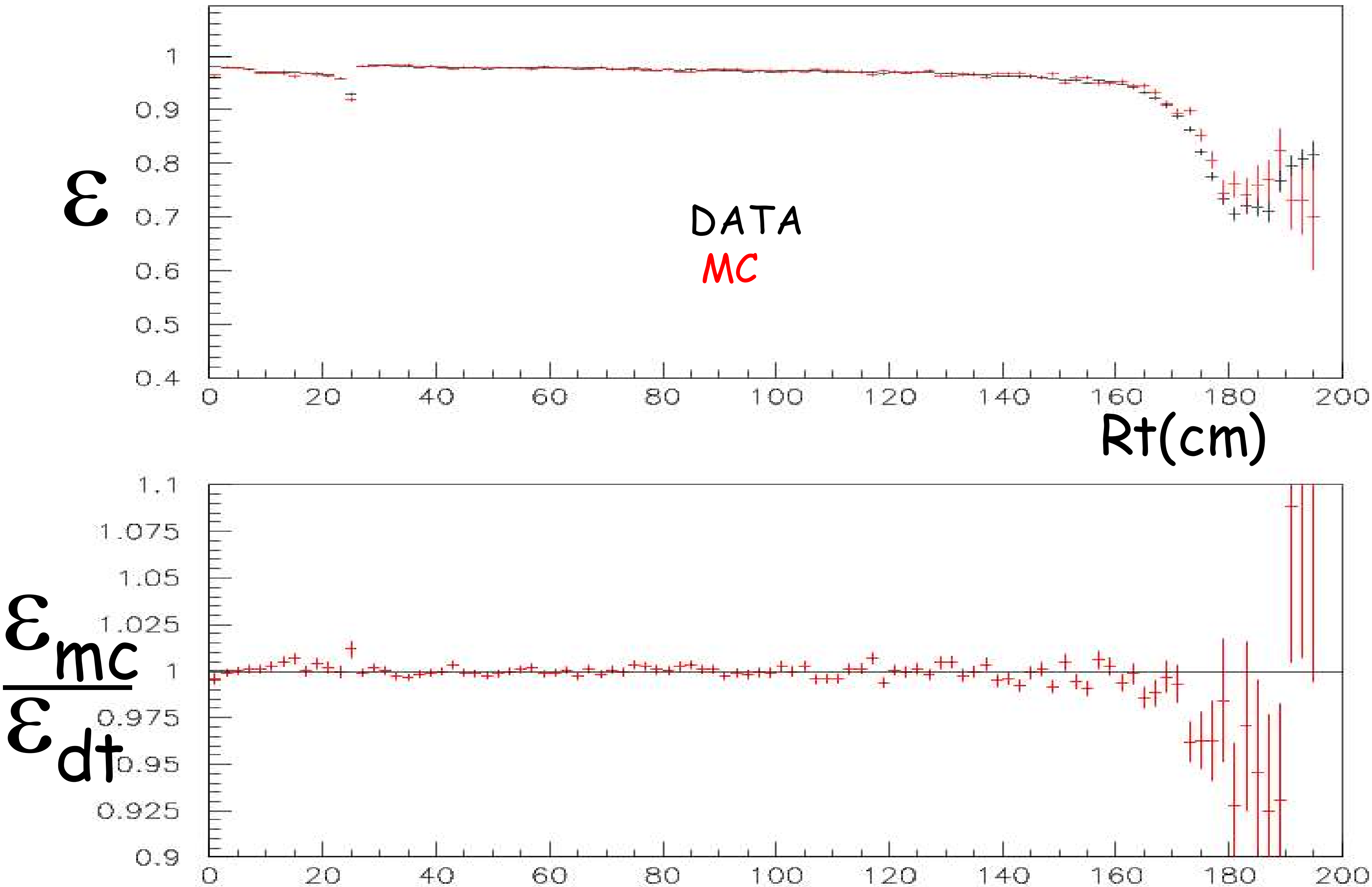
P(MeV)



R(cm)

The check Accuracy can be improved by using more data(x 3) and MC (x 10) and loosest Kltag (x3)

Vertex efficiency (2001 data)



Tracking and Vertex efficiency

- General good data/MC agreement for efficiency dependences but still ~1% overall difference
- New method added for $K_L \to \pi^+\pi^-\pi^0$
- Checks for different mode with PID requires π/μ calo. response tuning in MC
- Hardware efficiencies soon in MC
- New vertex efficiency: data/MC agreement at 0.1% level (there were ~1% differences with the old)

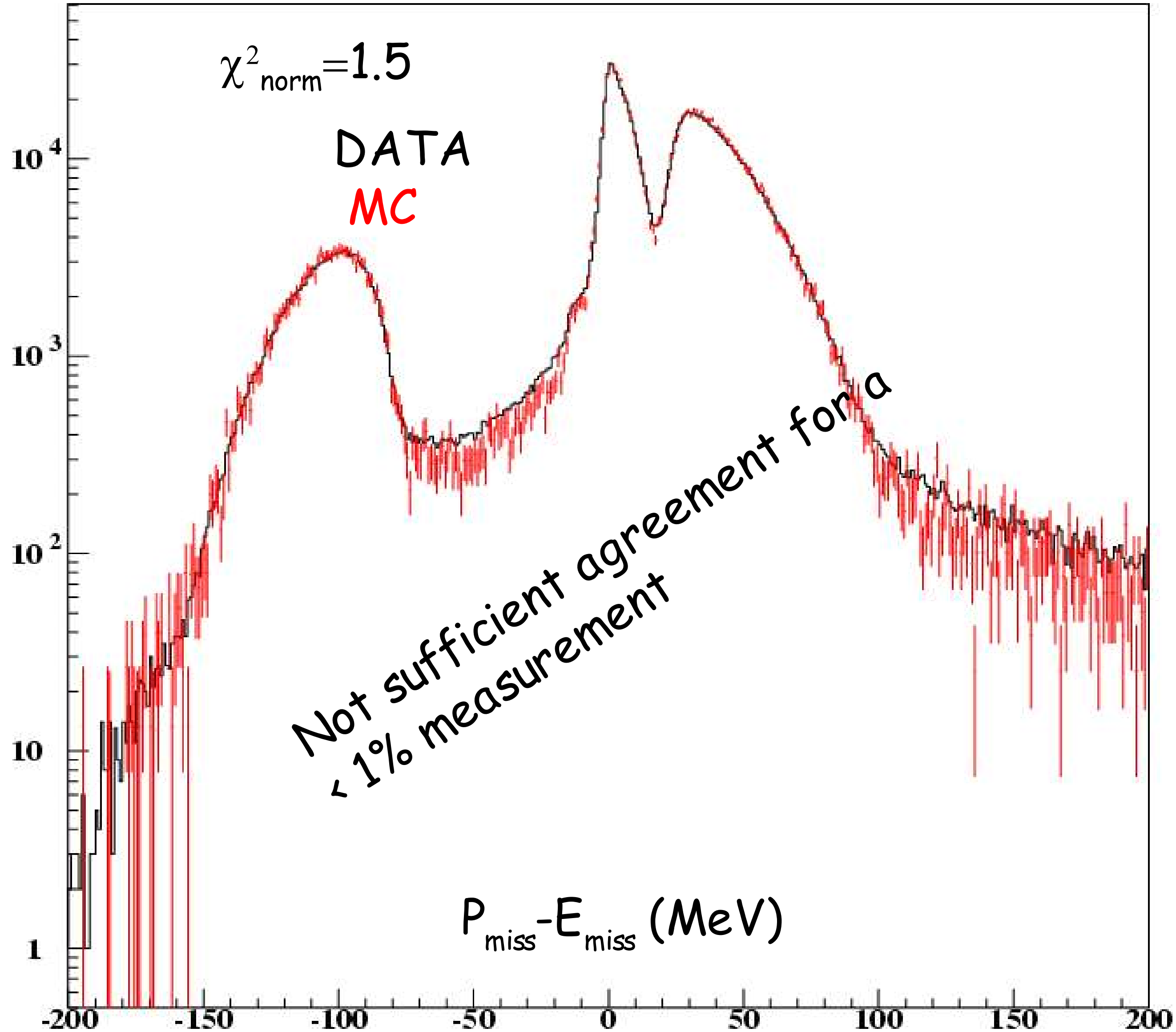
Signal counting: Kinematics

Several variables tried: P_{miss} - E_{miss} with mass hypothesis ($\pi\mu,\mu\pi$) giving min $|P_{miss} - E_{miss}|$

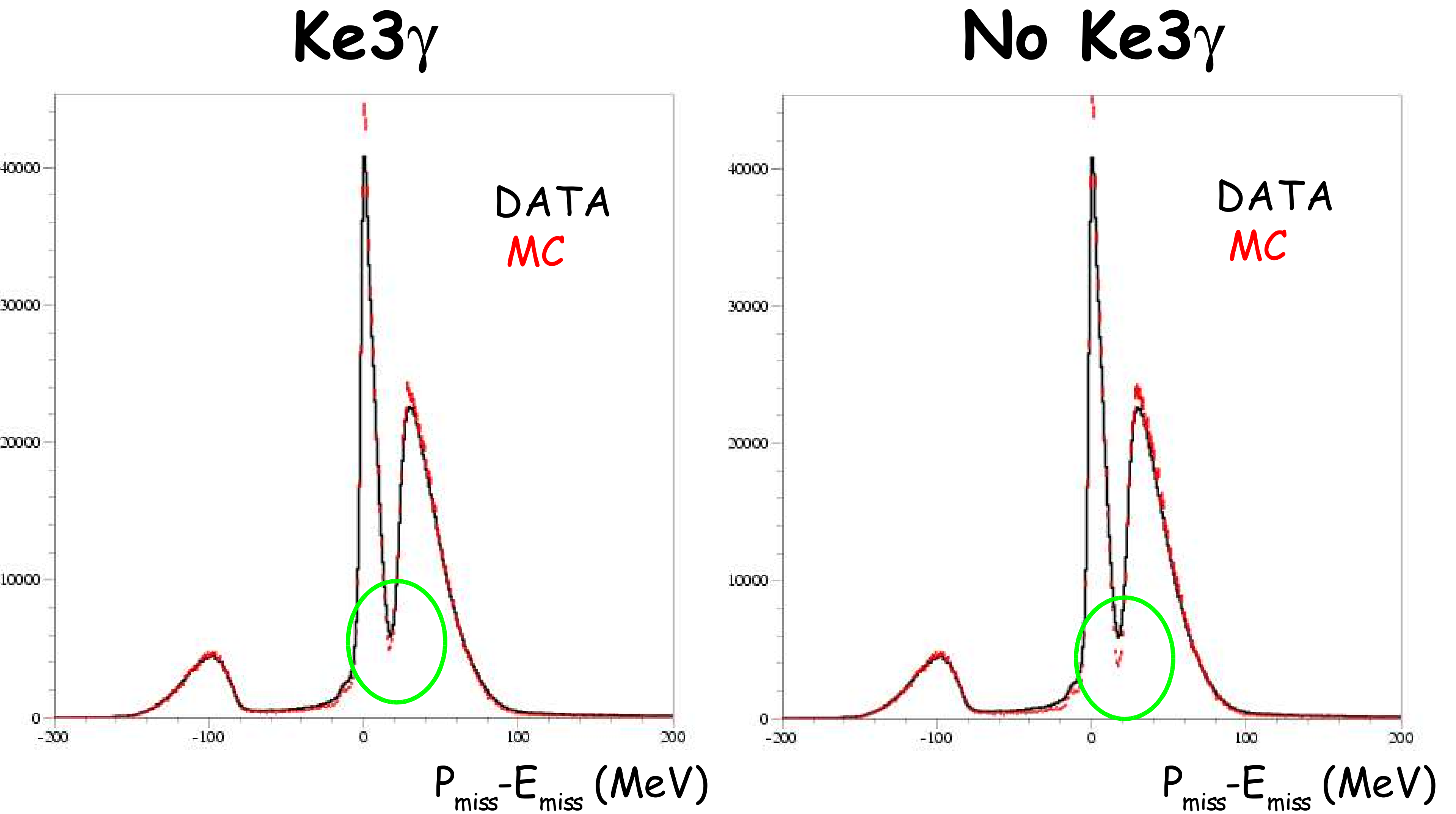
Fit to expected MC distributions 3 parameters

$K_L \rightarrow \pi^+\pi^-$

Fixed to expected contribution



Effect of the new Ke3γ generator



Effect of the new Ke3γ generator

- The use of the new generator produce a few (~5%) change in signals counting !!!!

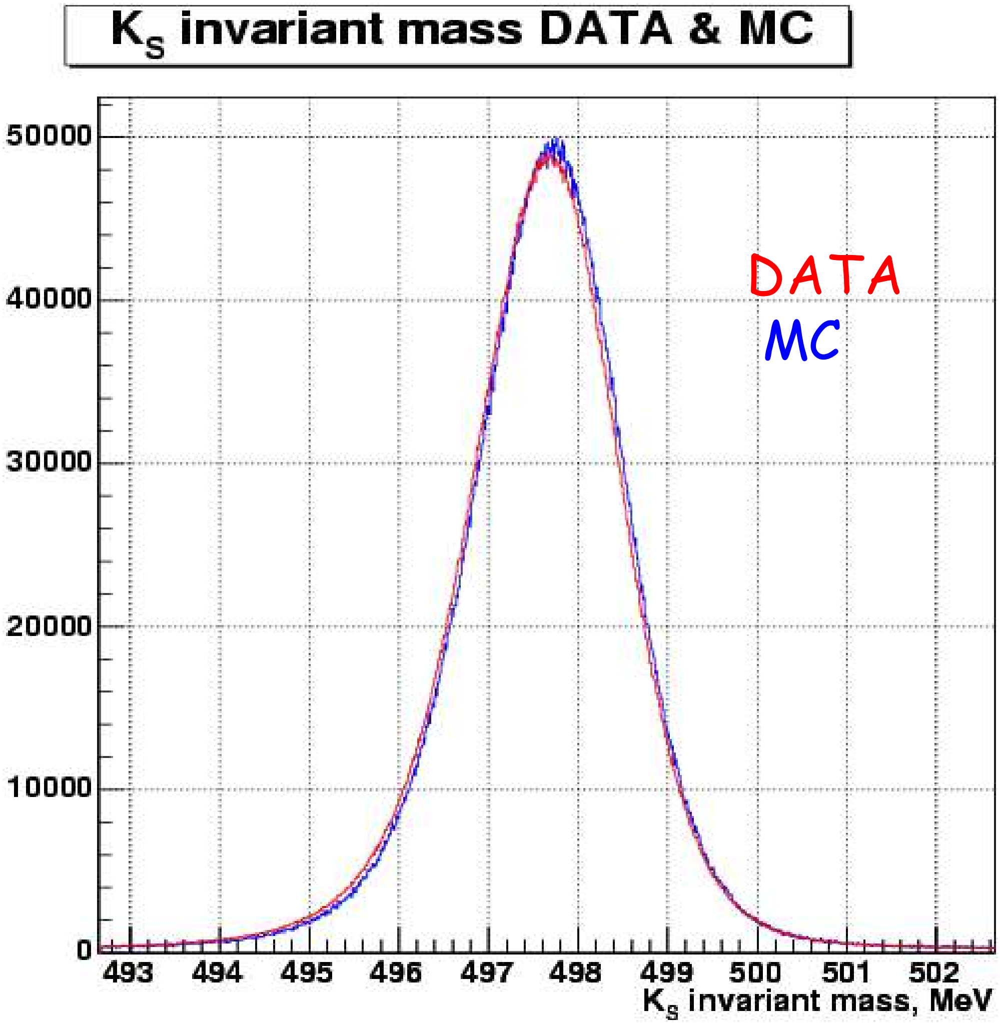
- the Ke3/Kμ3 increases

- INCLUDE Kμ3γ !!!

- the main difference w.r.t. Ke3 is the presence of F^- form-factor in the matrix element that can be neglected for our purposes (discussion with Gino and Claudio)

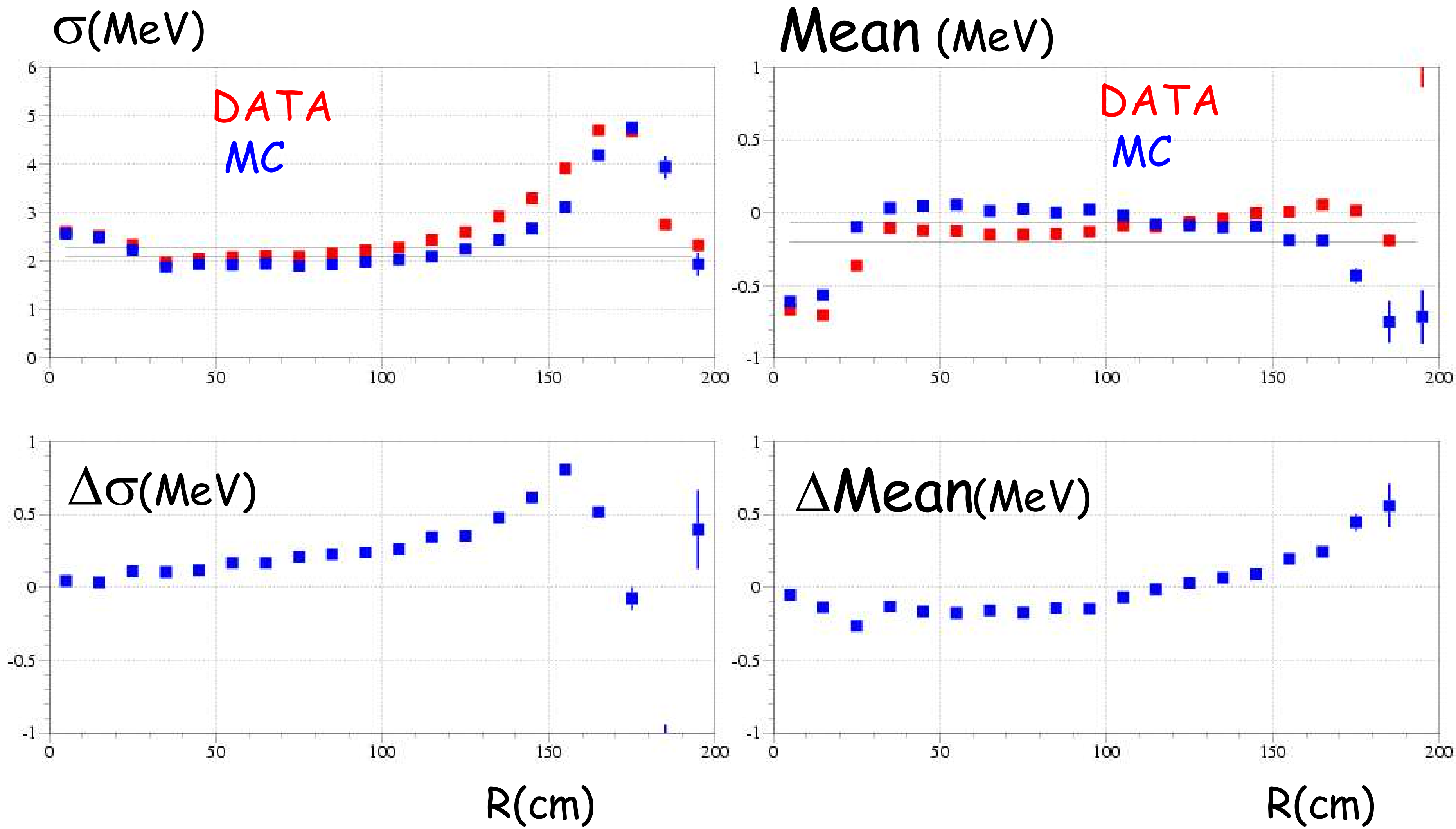
Resolution Studies:

All studies in different K_S,K_L channels indicate a good agreement when the vertex is close to IP



Resolution Studies: Kμ3 peak

Resolution and calibration



Signals counting for charged modes

- A $K\mu3\gamma$ generator with “no threshold” on the γ energy must be included

a smearing is needed for decay far from IP
a method based on genetic algorithm
worked well

need for independent checks from data !!!

again PID is required

from recent studies (Caterina, Marianna, Tommaso)
the MIP response has been tuned
still some problem with π^+ nuclear interactions

Neutral decay

The addition of the $K_L \to 3\pi^0$ is mandatory:

close the BR's

study of tag bias
$K_L \to 3\pi^0$ has the largest correction

Neutral vertex inserted in KCP

T_0, calibration and resolution, efficiency
have been studied with $K_L \to \pi^+\pi^-\pi^0$

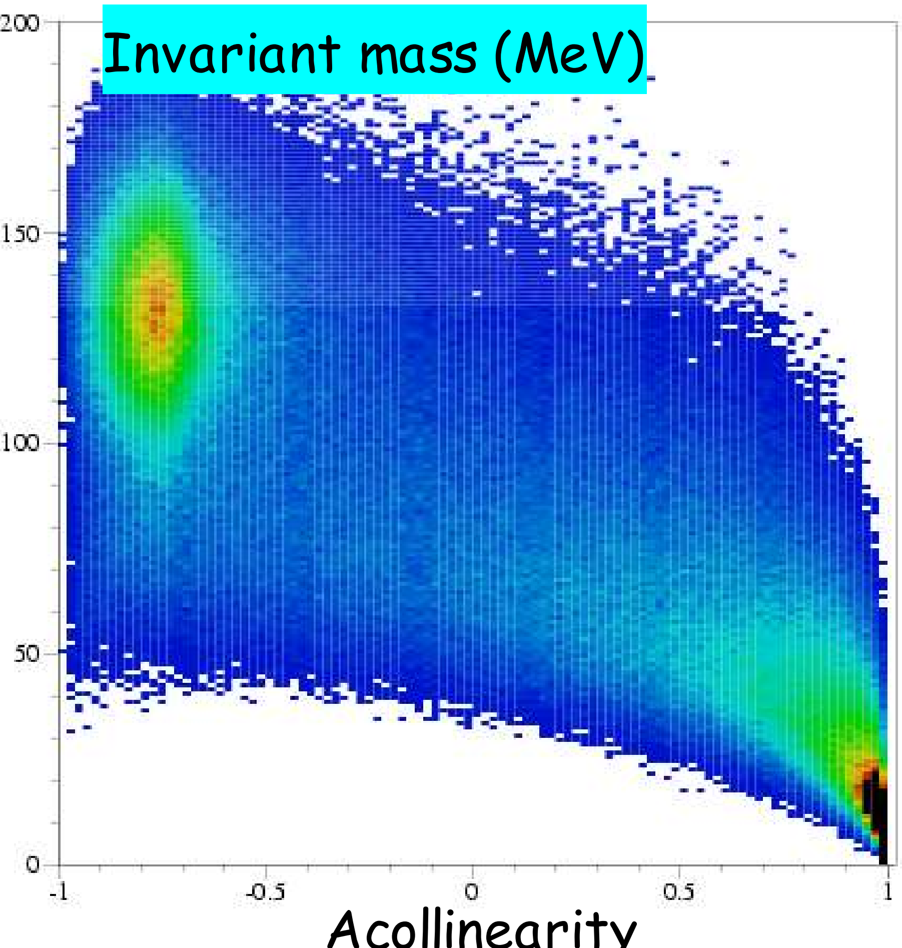
first results for tag bias

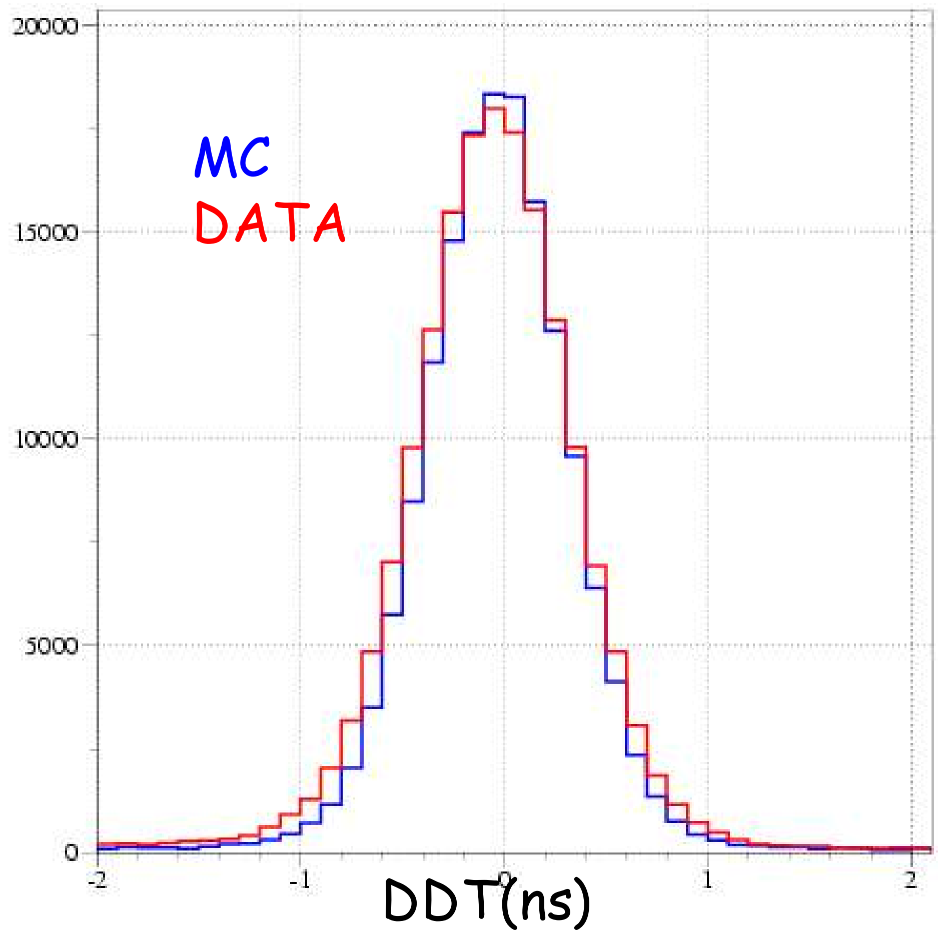
Neutral decay: $K_L \to \pi^+\pi^-\pi^0$ selection

Cut on $|\text{missing mass} - m_{\pi 0}| < 4$ MeV

photons quality:

invariant mass cut, DDT cut, acollinearity in the π^0 RoF



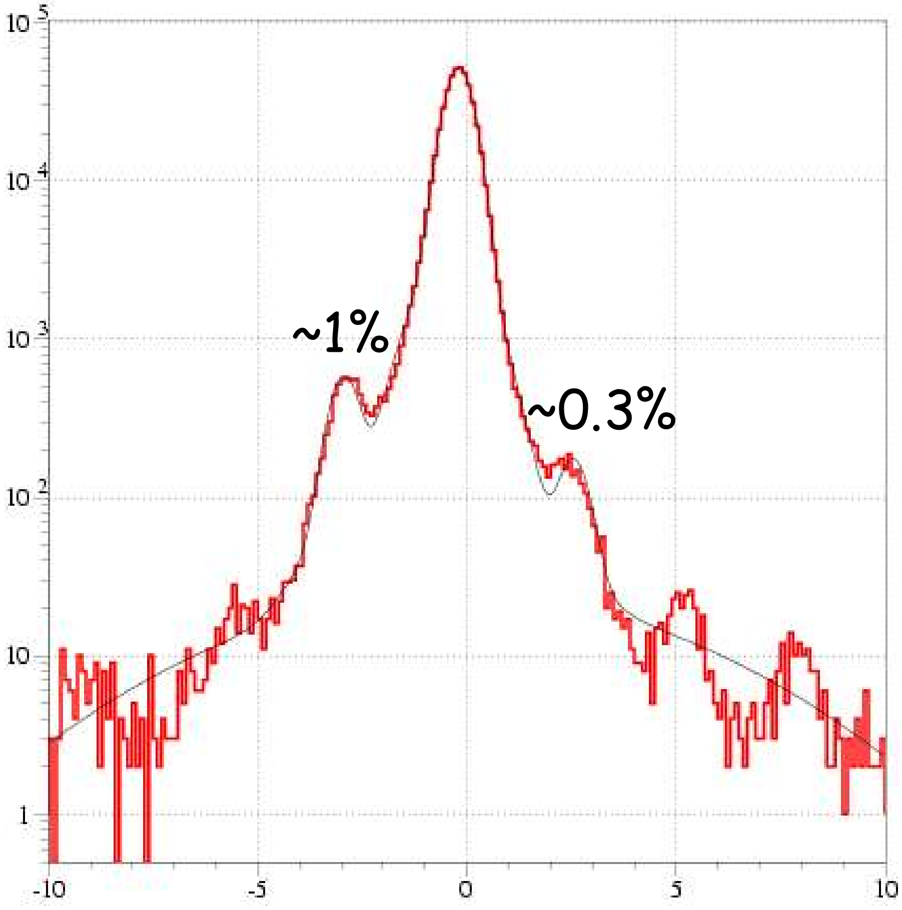


Neutral decay: T_0

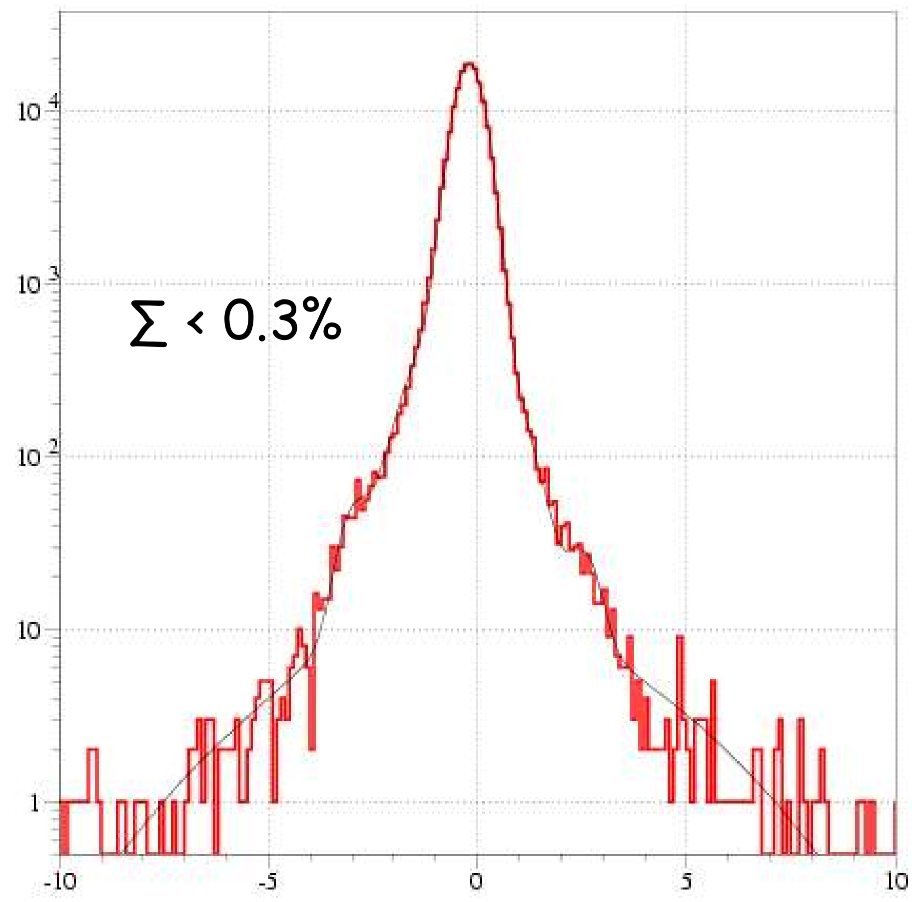
Bunch crossing determination is redone in KCP if one of the pion from K_S is associated to a cluster: we account for K_S ToF (Z position of ϕ is reconstructed event by event), K_S vertex, (we will add pezzetto soon). In case of two associated clusters and ambiguity we use the closest to the bunch crossing

Neutral decay: T_0

Loosest tag

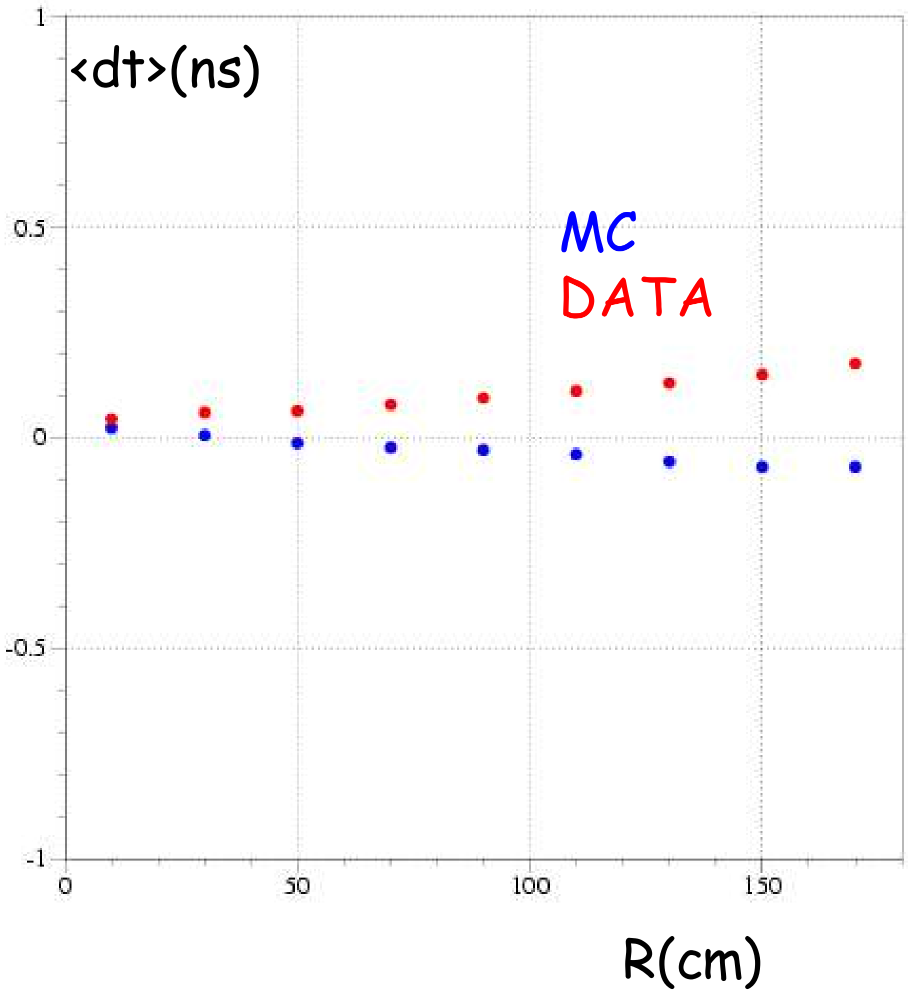


Unbiased tag

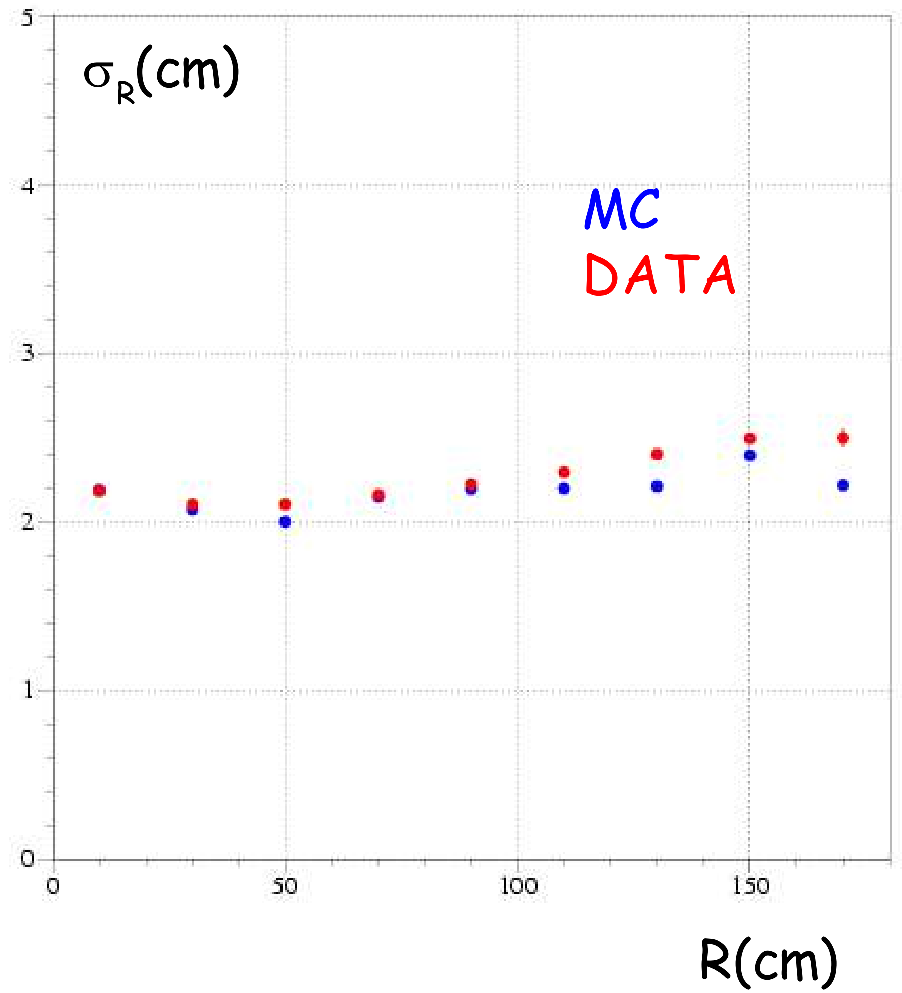


Neutral decay: calibration and resolution

calibration

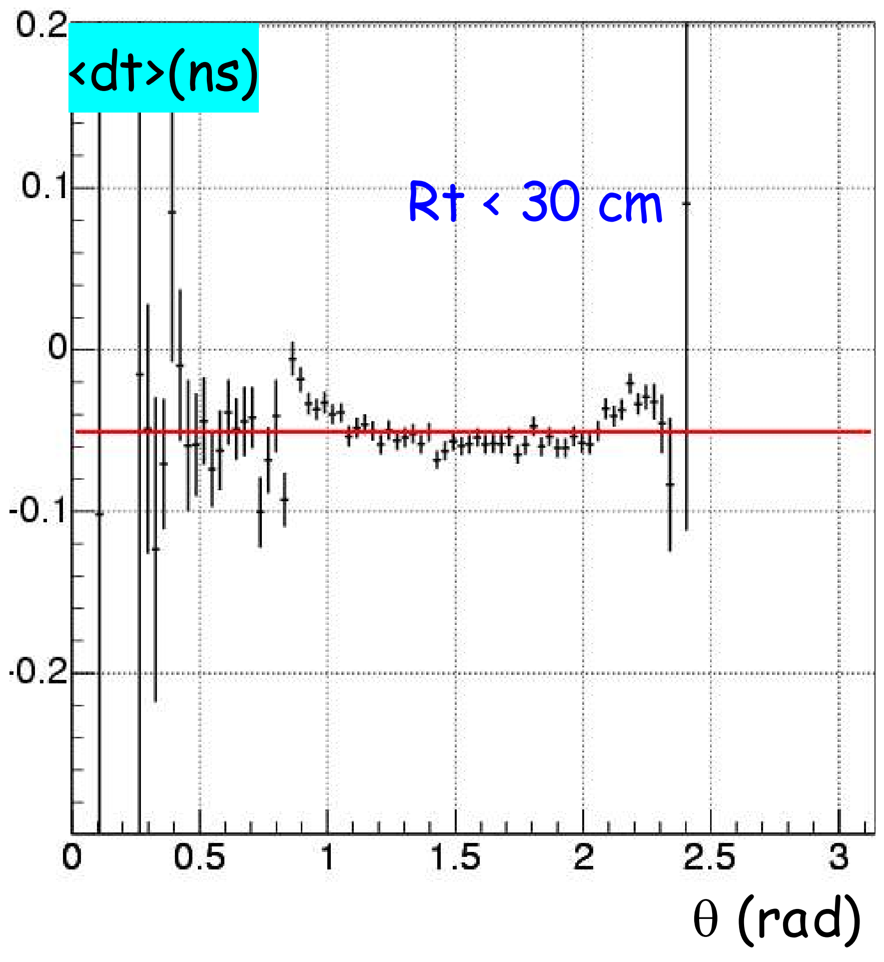


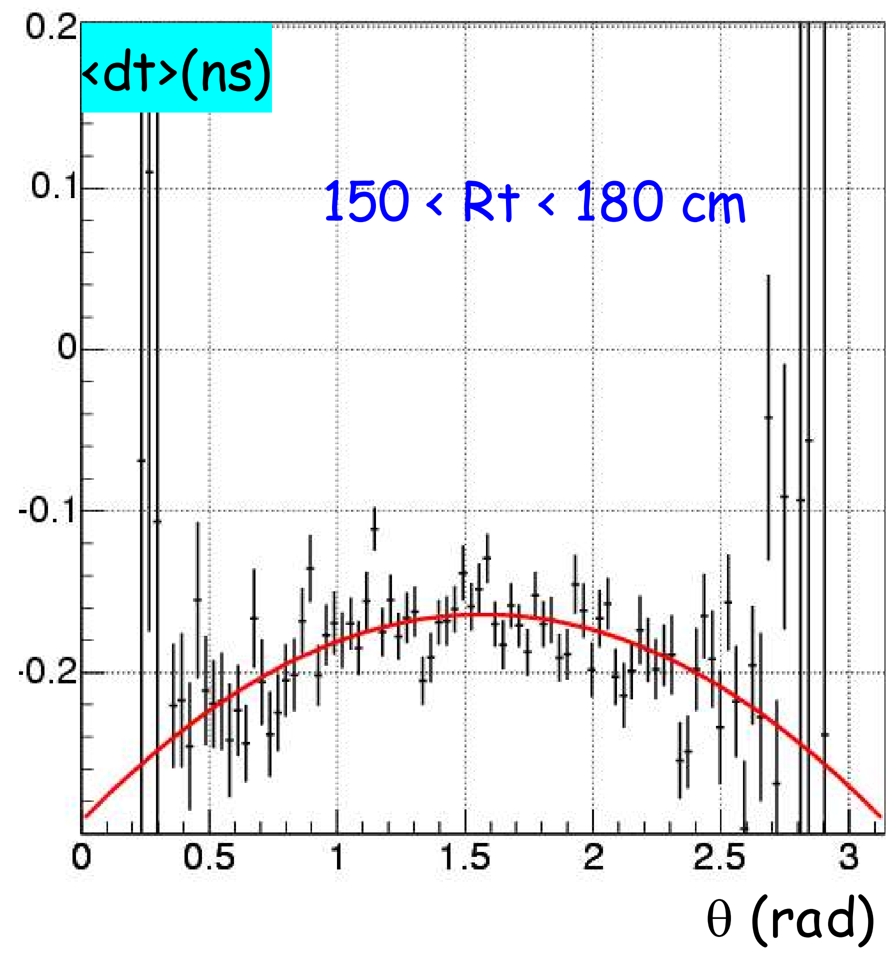
resolution



Neutral decay: calibration and resolution (BARREL)

Residual time miscalibration could be due to the time response dependence on the photon impinging angle





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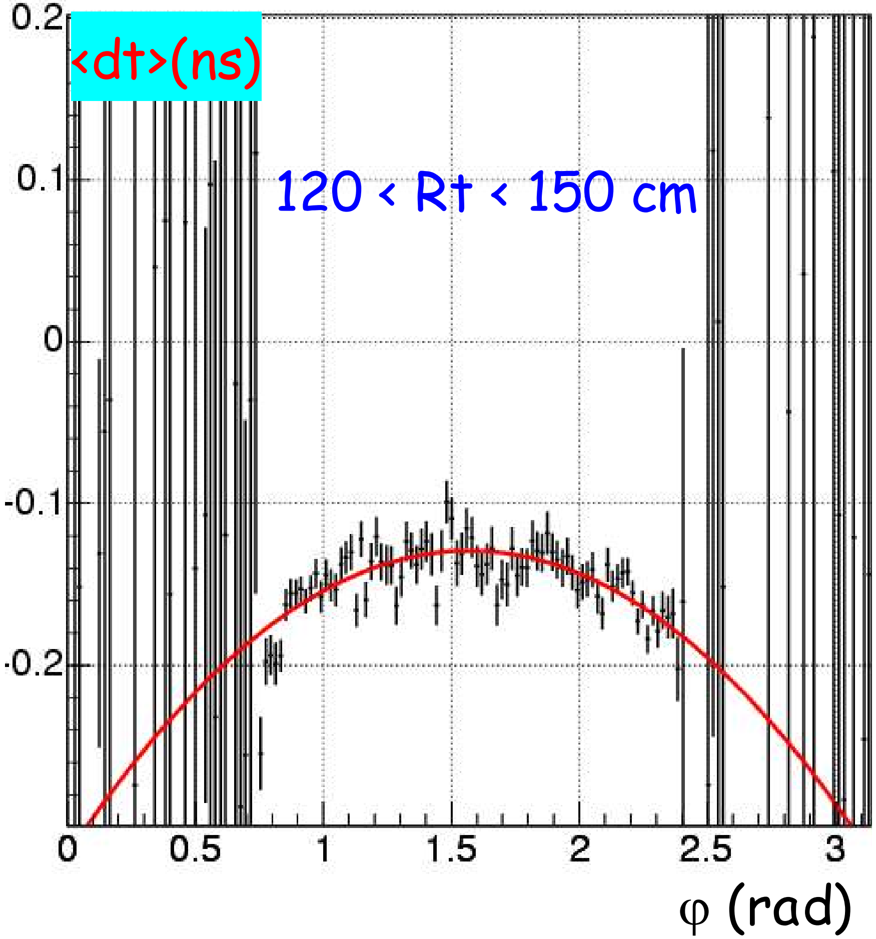
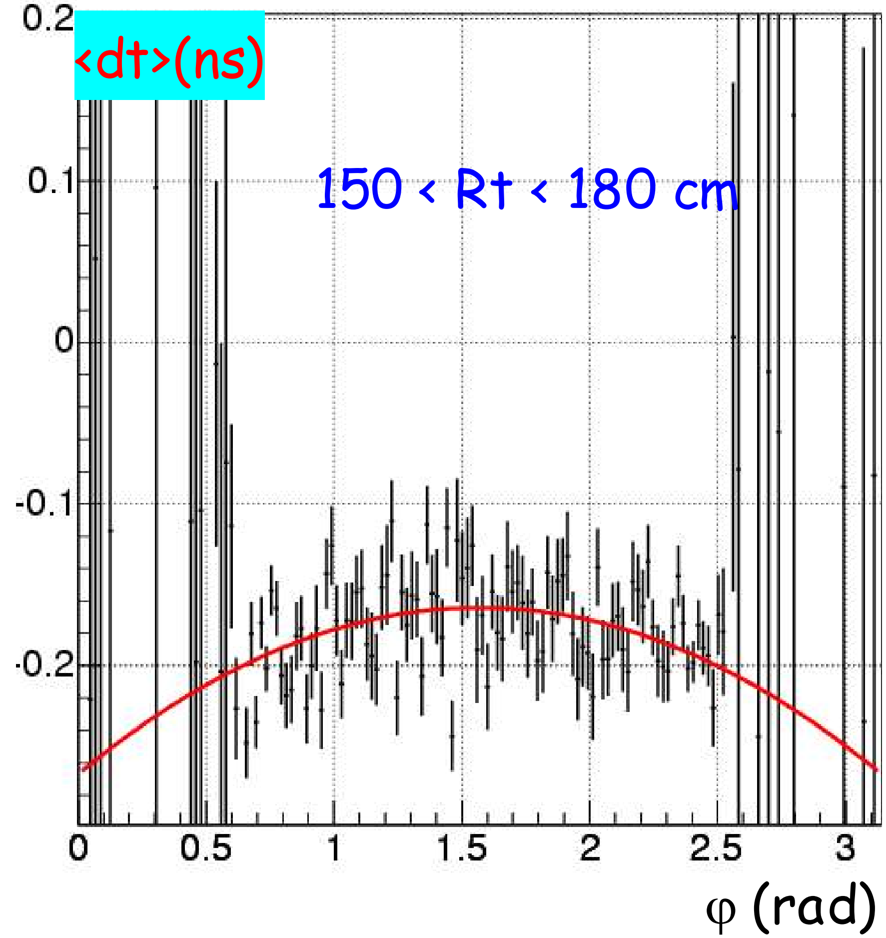
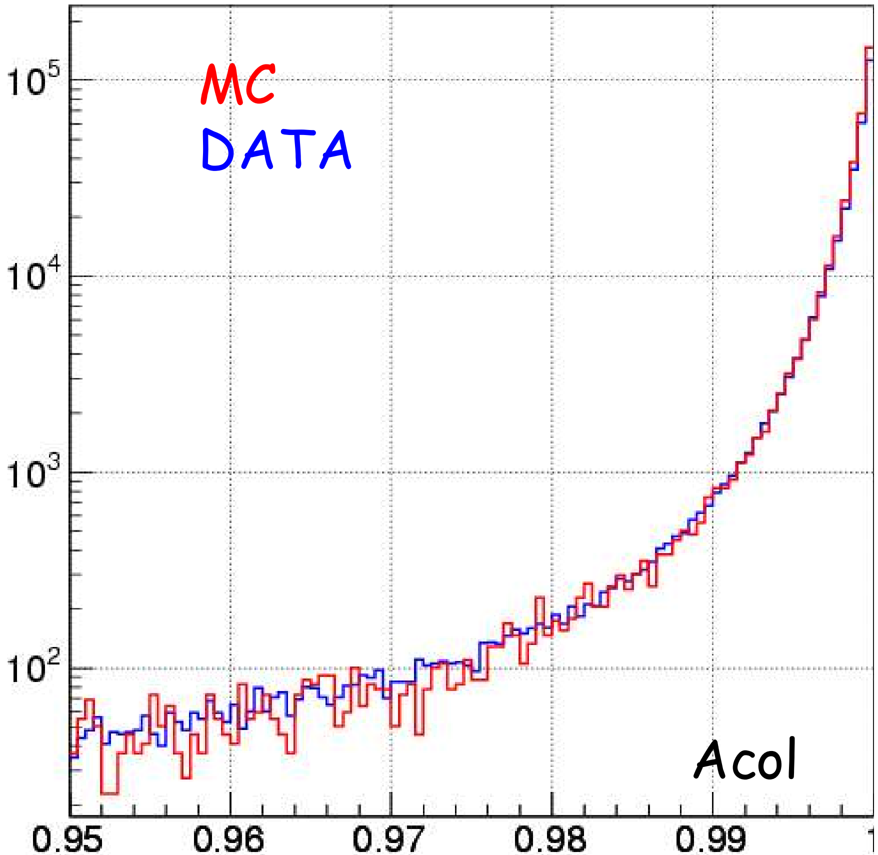
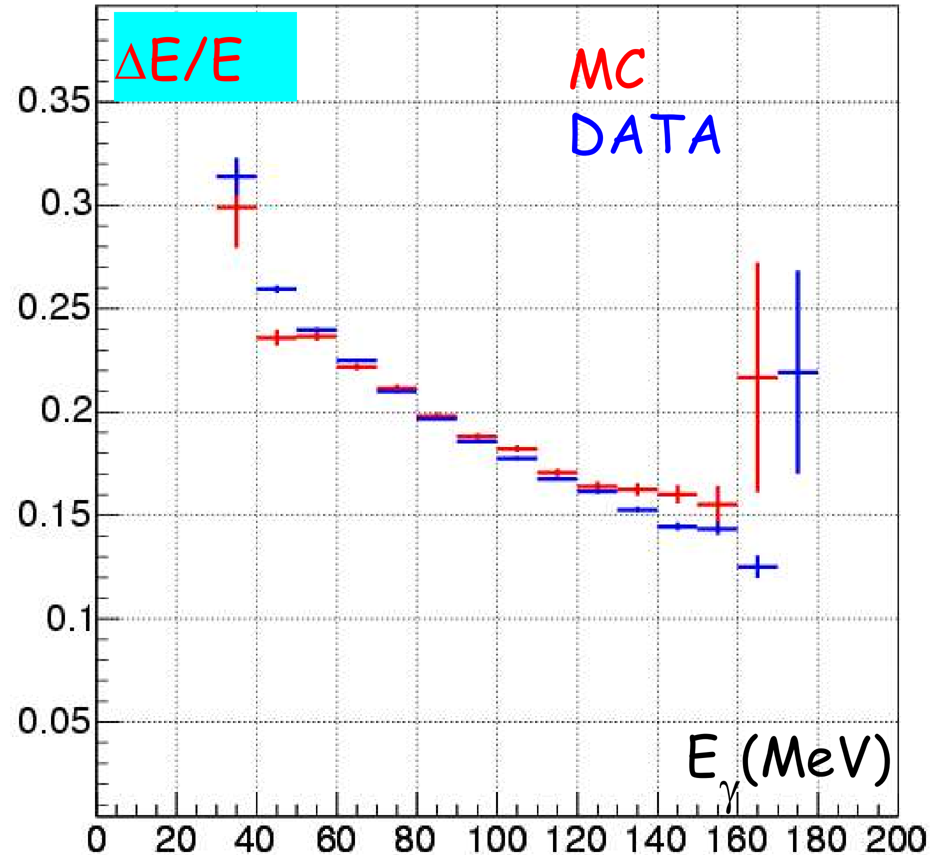




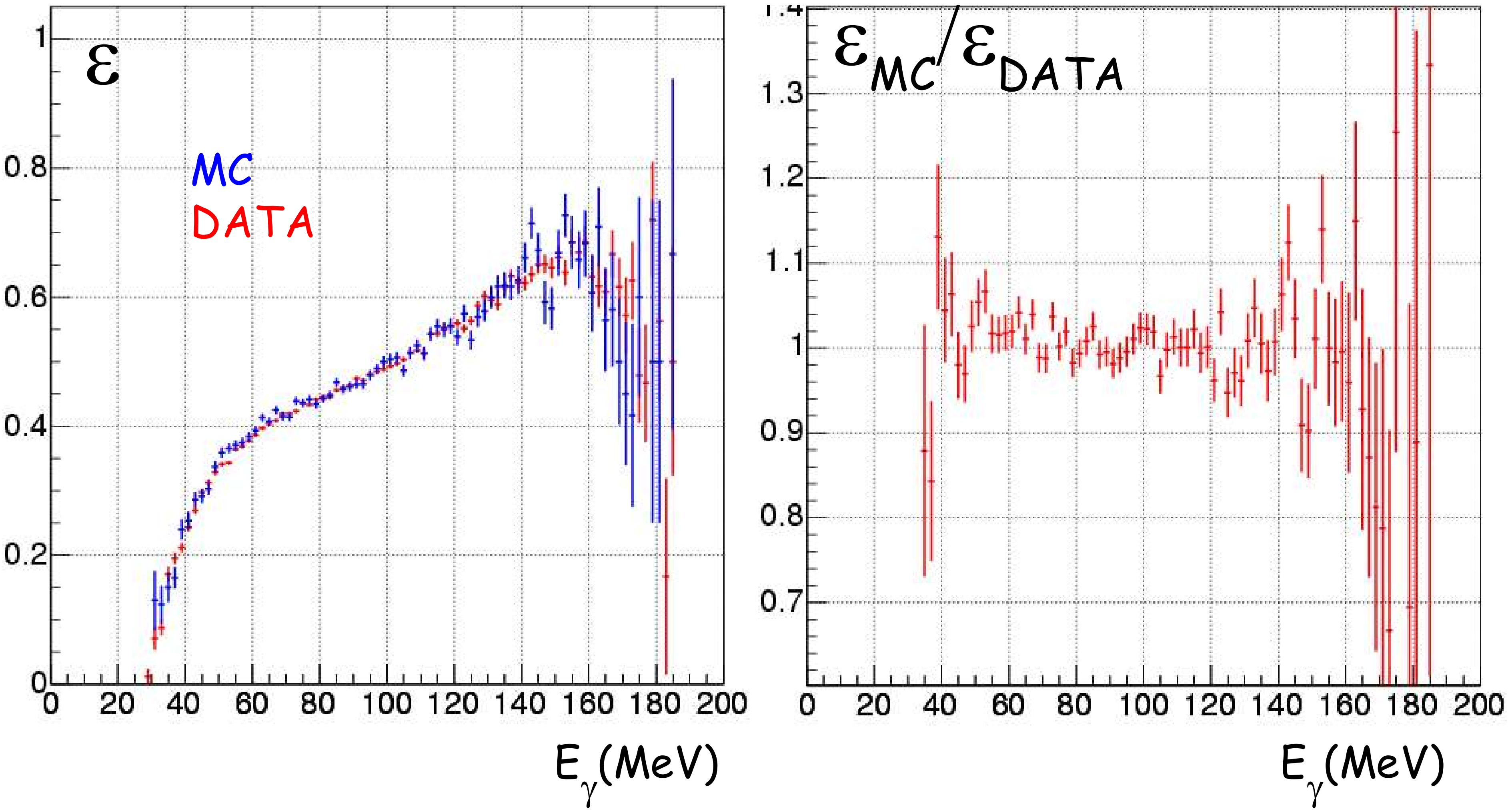
Neutral decay: energy resolution

Use $K_L \rightarrow \pi^+\pi^-\pi^0$ with a reconstructed photon and kinematic constarints:
Check energy resolution and efficiency for the 2nd photon





Neutral decay: photon efficiency



some dependence <60 MeV ? : Check with better statistical error
add 2002 data (+ ~40 pb^{-1} 2001) and neukaon MC (same statistic as data)

Neutral decay: Tag bias

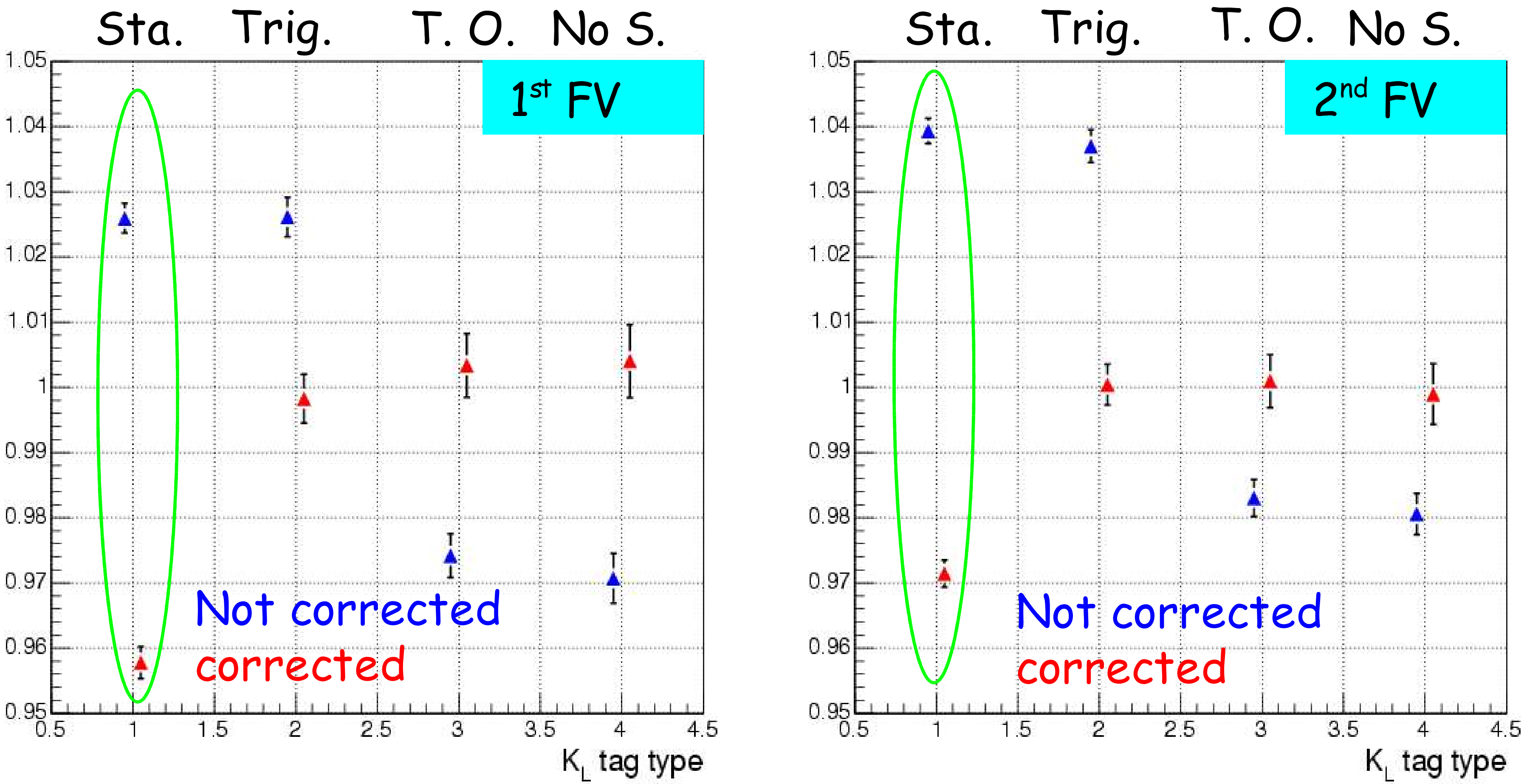
This channel has the largest bias $\rightarrow$

It is the perfect channel to study the effect

Check the measurement stability for various tags in different fiducial volumes:

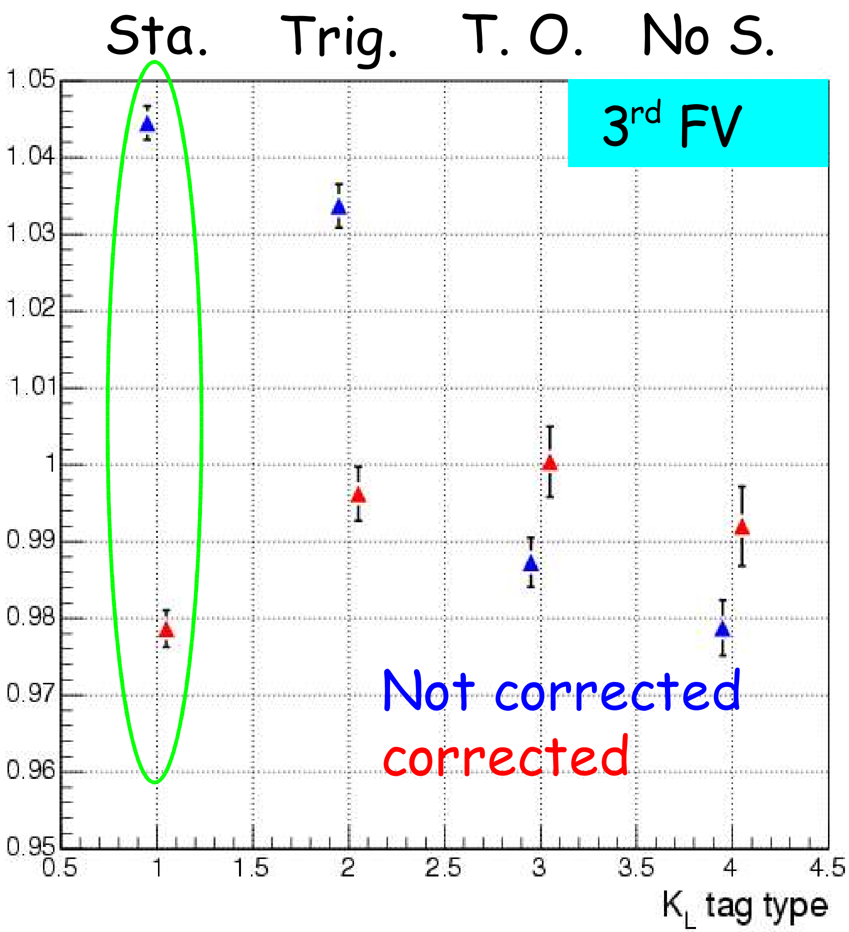
1 95 < R < 140 cm, |z|<100 cm
2 50 < R < 95 cm, |z|<100 cm
3 25 < R < 50 cm, |z|< 10 + 9/5*R cm
4 5 < R < 25 cm, |z|< 10 + 9/5*R cm

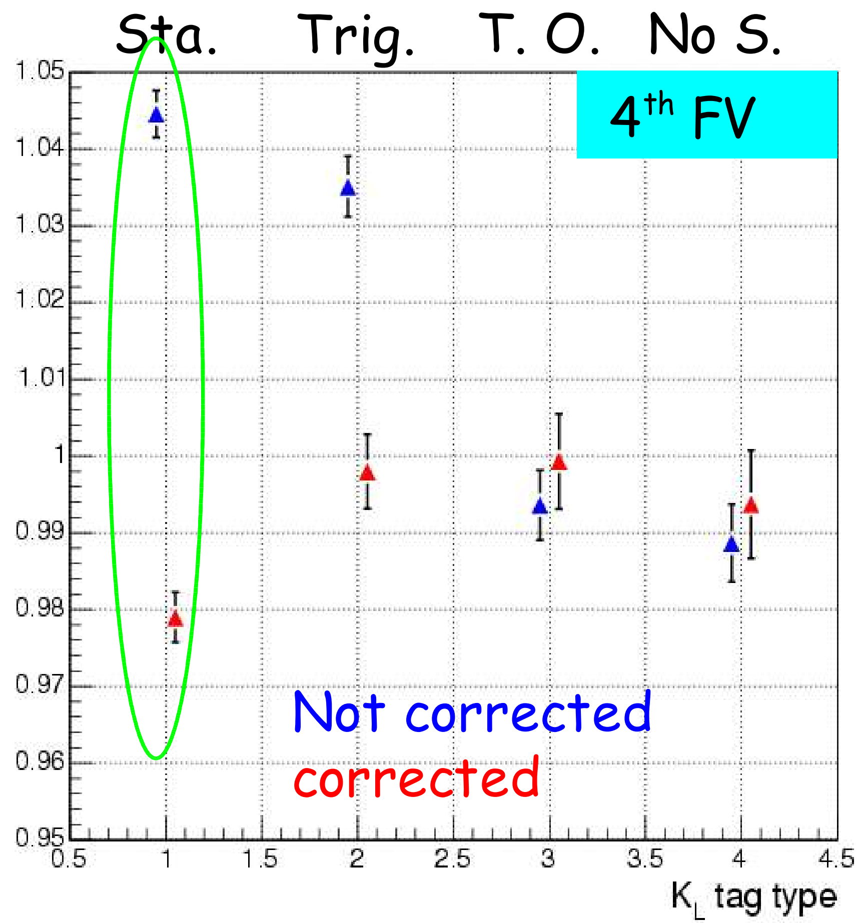
Neutral decay: Tag bias



Errors are correlated

Neutral decay: Tag bias





Errors are correlated

Conclusions

Many studies have been done for this measurment

- tracking efficiencies need ~1% correction
  - studies on selected channels

    cell efficiency in MC will give a better agreement

    vertex efficiency OK with new vertex
- some problem with shapes:

    generator with radiation

    + smearing
  - need for $K\mu3\gamma$
  - need to check shapes for different channels -> PID
- Neutral vertex:

    need for time calibration as function of γ impact angle

    γ effieciencies seems ok (add more statistics)

    γ energy resolution seems ok
- promising results for Tag bias

- Needed for ~0.5 % measurement (with additional checks on tag bias)